COST EFFECTIVENESS ANALYSES MODELS IN THE DEFENCE SYSTEM IN BULGARIA

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Abstract

The thesis resulting from the research on the „costs - effects" relation is the principle of economic efficiency of defence capabilities. At first glance, the arguments in this direction are well-known and popular in crisis situations of various nature, including the current financial and economic crisis in the country, the question about the cost of public welfare - security and defence is debatable. This cost is manifested through the defence capabilities of a country. In the new security environment the compilation of a National Defence Strategy is a priority of the Defence Ministry, which has more and more limited resources. This means that they should be treated as an economic activity. An economic activity is considered "any purposeful activity, allocating and combining scarce resources among alternatives, making it possible to maximize the outcomes and minimize costs." The ratio between the costs and benefits of a given resource or combination of resources to achieve a pre -defined objective is pushed to the forefront and the rationalization of management decisions is based on it. This necessitates a cost effectiveness analysis hence the evaluation of the outcomes (benefits) is manifested in the „cost - effect (benefit)" analyses.

Keywords: Analyses Models, Defence Systemq National Defence

Introduction

The implementation of „costs-effects" analyses can be used as a „planning tool; decision-making tool and an environment for historical documentation of decisions". Each of these „costs-effects" analysis directions has its place and advantages. Without neglecting any of them for the purposes of this paper the emphasis is put on the use of the „costs-effects" analysis as a tool for development and making decisions in response to the resource management question „what-if".

A starting point of the „costs-effects" analyses is the research and grouping of defence costs. In theory and practice, there is a number of significant researches, projects and papers in this field. Therefore for the purposes of this paper the focus is on the management approach to accounting organization, analysis and control of defence costs as a manifestation of „costs – effects" interdependence analysis.

Costs- as an economic category, in its multidimensionality is associated with the amount of resources spent to obtain any benefit. In this respect they reflect „the value of resources in their alternative use... -value of opportunities". They are always associated with a reduction of economic benefits when spent for any activity in public and economic life due to the reduction of assets (production factors) resulting from their incorporation in activity or taking out of the company or due to the increase in liabilities (obligations), resulting in reduction of the company capital, including state-run companies.

Depending on the characteristics of defence as a product, necessary to the public, and the costs associated with it, following the logic of the paper, account should be taken of the fact that „defence as an economic product is any commodity or service that can satisfy the needs associated with security."

Defence as a product has the basic features of any commodity or service, i.e. it is designed for exchange, is useful and meets certain needs. But due to the fact that it meets very specific needs (preservation of the territorial integrity of the country and improving its national security), it is distinguished by certain features which may be summarized as follows:

- collectivity of production and consumption of defence as a product necessary to the public, is expressed by its consumption indivisibility
- lack of market valuation of the price of defence as a product upon its consumption (as a monetary expression of its value);
- the usefulness of defence as a product is reflected in its capacity to meet the system's needs for security and defence, which determines its conditional nature, expressed in reaching certain operational capabilities;
- the realization of defence as a product, unlike the products of civil legal entities is not subject to a clearly formulated outcome of activity, such as profit, which makes implementation of the principle of economic efficiency and profitability of minor importance for the Armed Forces.

Despite these characteristics, an essential feature of defence as a product, necessary to the public is that its production is the result of combining the factors of manufacturing (material, financial, human, information flows) and the ratio between them. These factors are determined by the existing defence wealth, expressed in the accumulated material and spiritual goods, ensuring the rational functioning of the security and defence system of the country. A special feature of defence wealth is that on the one hand, due to the limited resources it has certain limits. On the other- „the absence of an accurate valuation of defence resources, and thus of the actual defence wealth impede the economic and efficient management of the actual defence and economic process and worsens the quality of the economic supply of defence system".

In the search for methods to overcome these limits of defence wealth and create defence products, comes the implementation of a management approach to reporting, analysis and monitoring of business processes in the field of security and defence. Such an approach allows an objective reflection of the size and structure changes of the factors of production of defence as a product, necessary to the public, within certain limits determined by the shortage of resources. It helps in bringing the security and defence resources management to the Euro-Atlantic standards.

The essence of the „costs - effects" analysis is expressed in the economic and efficient use of defence resources in the development of a National Defence Strategy of the Armed forces through the proper combination of the assets and the financial resources of the military institution at the proper time and place.

The initial thesis of the studies of the „expenses-effects" dependence is the principle of the economic effectiveness of the defense abilities. At first sight, the arguments in this direction are known and popular, but in the conditions of crisis situations of different character, including the financial economic recession in the country as well, the question about the price of the public security and defense remains subject to a discussion. The display of this price is through the defense abilities of a country. In the new security environment the foundation of the National Defense System (NDS) is a priority task of the military department, which has more and more limited resources. This means that they are to be approached as if they are an economic activity. As such is considered "every purposive

activity with which the limited resources are distributed and combined between alternatives where maximizing the effect and minimizing the expenses is possible" [1]. In the foreground comes out the correlation between the expenses and the uses of a certain resource or the combination of resources for achieving a certain, preliminarily defined goal and on that basis - the rationalization of the management solutions. This determines the necessity of an analysis of the effectiveness of the expenses and hence the assessment of the results (uses), which is displayed in the „expenses-effects" (uses) analysis [3].

The application of the „expenses-effects" analysis may be used as a „planning method; decision-making instrument and an environment for historic documentation of the decisions taken" [4]. Each of the mentioned directions of the expenses-effects analysis has its place and advantages. Without neglecting any of them, for the purposes of the present work, the stress falls on the use of the „expenses-effects" analysis as an instrument for the working out and taking of management decisions in response to the issue of the resource management „what-if".

The initial basis of the „expenses-effects" analysis is the studying and grouping of the expenses for defense. In the theory and practice there are a number of significant studies, projects and developments in this area. Due to this, for the purposes of this work, the stress is on the managerial approach in the organization of accounting, analysis and control of the expenses for defense as a display of the analysis on the „expenses-effects" dependence.

The expenses- as an economic category, in their multiple-aspect character, are connected with the sum of the spent resources for the getting of a benefit. In this sense, they reflect „the value of the resources in their alternative use….- value of the possibilities" [5]. They are always connected with the decrease of the economic use for whatever activity of the public-economic life due to the decrease of the assets (production factors) as a result of their implementation in the activity or their taking out of the company, or due to the increase of the liabilities, which leads to a decrease of the own capital of the company, including the budget one. Depending on the peculiarities of the product required by the society- defense, and the expenses for its support, following the logic of the expose, attention should be paid to the circumstance that "a defense-economic product is every good or service which may satisfy the necessities, related to security" [6].

The defense product has the common characteristics of every good or service, i.e. it is intended for exchange, it has the quality of usefulness and satisfies certain needs. But, because it satisfies specific needs (protection of the territorial wholeness of the country and increasing its national security), it is distinguished by definite peculiarities, which may be summarized as follows:

- collectivity of the production and consumption of the society-required product-defense, which expression is the inseparability during its consumption;
- the lack of market assessment of the price of the defense product during its consumption (as a monetary expression of its value);
- the usefulness of the defense product is expressed in its ability to satisfy the needs of the system for security and defense, which predetermines its conditional character and which expression are the reached necessary operational abilities;
- the realization of the defense product, in contrast to the products of the civil economic subjects, is not subject to the clearly formulated purpose of their activity- the profit, which makes the application of the principle of the economic effectiveness and profitableness of secondary importance for the Armed Forces (AF).

Notwithstanding the above-mentioned peculiarities, an essential characteristic of the society-required product- defense- is that its creation is a result of the combination of the production factors (material, financial, human, informational flows) and the correlation between them. These factors are determined by the existing defense richness, expressed in the

accumulated material and spiritual goods, providing for the rational functioning of the security and defense system of the country. A distinguishing feature of the defense richness is that, on one side, due to the limitation of the resources, it has no definite borders. On the other side – "the absence of an exact value assessment of the defense means, and along with that, of the real defense richness, makes difficult the economic and effective management of the real defense-economic process and worsens the quality of the economic provision of the defense" [6].

In the search of ways for overcoming the mentioned restrictive characteristics of the defense richness and the creation of the defense product is the application of managerial approach in the accounting, analysis and control of the business processes in the security and defense sector. One such approach allows for the objective reflection of the modifications of the size and structure of the factors for production of society-required product- defense- in definite limits, determined by the resource deficit. It contributes to the nearing of the management of the security and defense resources to the Euro-Atlantic standards.

The essence of the „expenses-effects" analysis is shown in the economic and effective spending of the defense resources in the construction of NDS of the Armed Forces (AF) through the proper combination of the elements of the property and financial status of the military department at the required time and place.

The analytic indicators for effectiveness are applicable in the accountancy-analytical practice for the needs of the „expenses-effects" analysis. Such are the quotients of effectiveness of the expenses and the incomes. The quotient of the expenses effectiveness is the correlation of the incomes to the expenses, which shows how much income is received from expenses equaling 1 lev. The quotient of the incomes effectiveness is the correlation of the expenses to the incomes and shows how much expenses are made with incomes equaling 1 lev.

In accordance with the above-mentioned peculiarities of the defense products, the adaptation of the application of the effectiveness indicators is advisable and economically-grounded. In this sense, they are displayed in the determination of the effect, obtained with expenses of 1 lev for support of the defense and in how much expenses are done with one unit of effect. The application of the effectiveness indicators, apart from allowing the rationalization of the military solutions, is also grounds for revealing the factors leading to the ineffective spending of the resources, servicing the defense system of the country.

The application of the expenses-effect analysis is closely related to the determination of the actual price of the defense resources, known as a historic price. It is in the basis of their assessment and their reduction to a common indicator for commensuration and juxtaposing as is the value one. The calculation is in a direct dependence with the assessment of the expenses for the support of the defense product. It is in a mutual relation to the organization of the accountancy reporting of the expenses and their management, aiming at decreasing the indefiniteness of the actions (market and military ones). One such organization for accounting the expenses for support of the defense is based on the application of the principle of the „optimal analyticity" [7]. The application of this principle is conformed to the informational needs and possibilities for their provision, requiring the receiving of a maximum quantity of information, having the proper quality with minimum costs of public labour. It is in the interest of the efficiency and results of the financial-accounting analysis and the control of the process of creation of the defense product.

The effect of the application of the „optimal analyticity" principle in the resource management of the security and defense is shown in the creation and rational use of the NDS for the provision of stability and security of the economic growth of the country and increasing the value of the money. In its essence, this is the goal of the actions of the Armed

Forces and Bulgarian Army in peaceful times, which substitutes the profit as a final result from the functioning of the security and defense system.

The application of the analytical approach for management of the security and defense resources requires also the proper grouping of the expenses. In the theory and practice are known many criteria for grouping of the security and defense expenses (known also as military expenses). Every grouping is a reflection of the specifics in the structure of the defense expenses, which are one of the main elements of the state expenses, which consumption, at first sight, is unproductive. In this context, the financial theory and practice considers the security and defense expenses in accordance with their expression in the following three groups: direct, indirect and hidden [8].

The direct expenses for security and defense in their essence provide for: the support and preparation of the Armed Forces; their equipment with high-tech armaments and equipment as a direct consequence of the broad entering of the electronics and the new information technologies in the defense processes; the support of the personnel and the scientific research activity to the military programs.

For the needs of the budgeting of the expenses for the military department, the direct expenses for security and defense include the investment-, current-, professional and social adaptation expenses, the expenses for the information-communication technologies and the expenses for scientific-research and development activity. The tendency in the structure of the direct expenses in a world scale and in Bulgaria is towards increasing the investment expenses relating to the implementation of the high-tech systems. This is in response to the compatibility of the military staff with that of NATO and conforming to the "new face of the war". To counterbalance that increase of the direct expenses, the expenses for support of the personnel (called also current expenses) are with a tendency towards decreasing. One should not approach this tendency simply. The unproductive character of the defense expenses and their relation to the monetary mass, the inflation, the debt and tax burden, reflect on the budget deficit, depending on which is also the level of the direct expenses.

This is only on the one side. The state consumption, being part of the Gross Domestic Product and the technology for the army, except for „tanks, airplanes, fuel…, is expressed in technologies, which are open for civil use and bring money" [9]. The examples in the world practice in this relation are many: Global Positioning Service (GPS) the system, which as a military development is in favour to the civil economy; know-how in the aviation industry, used in the civil aviation and the air space control; in the pharmaceutical industry, etc. [9]. On this background of the modernization of the Armed Forces and the Bulgarian Army, the investment in western licenses provide a front for revival and infusing of fresh capital in the companies of the defense industry, having a potential in the area of the communications, radio-locations, bio-chemical protection. This approach, except for providing a perspective for the defense industry and the other branches of the national economy, has also influence on the increase of the employment, the attraction of foreign investments, the increase of the capital, the equipment of labour and the competitiveness of the companies. Hence the increase of the incomes, savings and the increase of the quality of life as factors and indicators of the economic growth, understood „in broad sense" [10]. The mentioned effects are a precondition for neutralizing the negatives from the increased budget deficits, as well as the other consequences from the allocation of the resources.

The indirect expenses for security and defense in their essence are such which are not directly related to the support of the military potential, but influence its formation. Such are the expenses for the state debts, the expenses for the humanitarian operations and restoration of the damages caused by war, the expenses for compensations for the killed in peace-keeping operations.

The unproductive character of these expenses is a precondition for the increasing of the unproductive state consumption. It is accompanied by a loss of effectiveness in the allocation of the budget resources, expressed in the real size of the proportions between the goals and the tasks and the deficit of the resources for their achievement. Not without importance are also the missed benefits for the business processes, which final result is the decrease of the possibilities for the economic growth, the decreased consumption, the worsened living standard.

The hidden expenses for security and defense are related to the programs of the civil organizations, having attitude to the security and defense programs; the expenses for infrastructural projects, originating from the challenges of the security environment and from the membership of the country in NATO; the deliveries for the army through the public procurement system. In their essence, these expenses, to a greater extent, are in the basis of the macro-economic development, confirmed by the circumstance that the war, for those who create its instruments, is a very good business. Still more, „the things that shoot and kill people are sought and sold as warm bread" [11].

The so-mentioned grouping of the security and defense expenses allows for the analysis of the effects from them. With such an analysis it is advisable to approach it from many sides. Notwithstanding the commonly-accepted thought of Milton Friedman for the military expenses as part of the state expenses, that „when somebody spends some else's money on somebody else, he is neither concerned how much money is spent, nor the way it has been spent" [12], they in a direct, indirect or hidden way are reflected in the economic growth. This is a two aspect reflection, expressed through the positive and negative effects from them.

The grouping of the expenses according to the so-called "tree of expenses" is also known in the specialized literature [13]. It is about the grouping of the general expenses in expenses related to labour and related to capital, expenses with obligatory sizes and of recommended character, expenses for keeping a basic potential, for upgrading the potential, for realization of the potential, mutually related and mutually unrelated expenses, personnel expenses, operational expenses, capital expenses, direct and indirect expenses, etc.

Following the logic of the report, a starting point for the research in this direction is the analysis of the budget of the military office for the 2009/2013 period, as well as the level of achieved results (effects) of the performance of the defense programmes. The choice of the analytical period is in accordance with the defined common priorities, set out in the memorandum of the programme decisions for 2008÷2013 and the three-year budget estimate for the 2012÷2014 period [14]. These are the priorities envisaged in the midterm six-year plan for the development of the Ministry of Defense /MoD/ and AF and the Programme Guidelines 2010÷2015, the Defense Policy Guidelines of the Minister of Defense 2011÷2014, underlying the White paper on defense and the Armed Forces.

The analytical estimates are illustrated by graphs and diagrams, the causalities and dependences of the changes and results are derived, the measures for evaluation of the established priority abilities are motivated, both for our country and for the NATO member-states, together with their contribution to the collective defense and their actual participation in operations.

On this basis a mathematical model is developed, which is founded on the black box model and supports the 'resources-abilities-effects' model in an environment variable for security. This method is widely used in various fields of science where the solution to a problem is based on the specific situation. It is assumed that there is a functional relationship between the „input" and „output", and the way the specific components operate within the system, is unknown or is the subject of research. It focuses on the factors and the random effects that have an impact on the object and these are usually hard to measure. What is

usually noticed is the effect of the factors when measuring the input values. Thus, on the basis of the model structure, through the possibility for interpolations, the value of the unknown variable of the function is determined in the array of experimental data. This is exactly the main advantage of the black box model which allows the processes to be modelled and optimised. The choice of this method for mathematical modelling is the result of all this, following the logic of our scientific searches and the model of transformation of the resources into defense abilities and also a result of searching for an answer in „what-if" situations. The applicability of this method for the purposes of our researches follows a specific logical scheme, defined by the conditions for functioning of the security and defense system, the linear prediction (trend) of the future expense, the application of the regression analysis (general, local, multidimensional), dispersion, hypothesis, correlation dependences, the synergic effect. The mathematical modelling is done with the help of the MATLAB application.

For this purpose an algorithm is used for determining certain characteristics of the dynamic time series by years of funding.

The military budget generates an end product of financial resources R_{fin}, defense abilities A_{cap} and final effects from them E_{ff}, which could be presented as a functional dependence as follows:

$$B_{mil} = f(R_{fin}, A_{cap}, E_{ff}) \quad (19).$$

The realization of the military budget in the given dependence (19) could be presented as an hierarchy as follows:

$$B_{mil} = (R_{fin} \rightarrow A_{cap} \rightarrow E_{ff}) \quad (20)$$

The military budgeting is usually characterised by structural description of each situation, forming the costs for defense C_{mil}^{f}, occurring in each subsequent year – space due to a change in the economic environment. Structurally, C_{mil}^{f} consists of defense policies D_{pol}, defense programmes D_{pro}, which could be presented functionally a follows:

$$C_{mil}^{f} = f(D_{pol}, D_{pro}) \quad (21)$$

The allocation of costs C_{mil}^{f} in (21) is done in an hierarchy of the type $C_{mil}^{f} = (D_{pol} \Rightarrow D_{pro})$. Thus presented, it provides a possibility for generating a multitude of solutions and a choice of the most acceptable among them, satisfying predefined conditions for functioning of the whole system M_{sys}, related to the defense of the state.

Therefore, the set of conditionally adopted formal objects B_{mil}, R_{fin}, C_{mil}^{f}, A_{cap}, E_{ff}, D_{pol}, D_{pro}, which structure, formalize and determine the functioning of the system for security and defense, suggests a model for analysis and forecasting, or

$$M_{sys} = f(B_{mil}, R_{fin}, C_{mil}^{f}, A_{cap}, E_{ff}, D_{pol}, D_{pro}) \quad (22).$$

The interdependence of the objects in (22) suggests a description of the relationships between them through a pragmatic mathematical model, comprising a few steps for a certain period of funding.

Step 1.Determining the interrelation between the total defense spending of C_{mil}^{f} on the policies for the defense for a specific time period T_{mil} - start T_{pr}^{start} and end - T_{pr}^{end}. This is

realized through a regressive analysis of the dynamics of the total costs of defense policies in the form of an equation $P(x)$ of the following type:

$$P(x) = a_0 + a_1x^1 + a_2x^2 + a_2x^3 .....a_nx^m \quad (23),$$

where: a - coefficients of the regression equation; n - serial number of the coefficients of the equation; m - exponent of the variables.

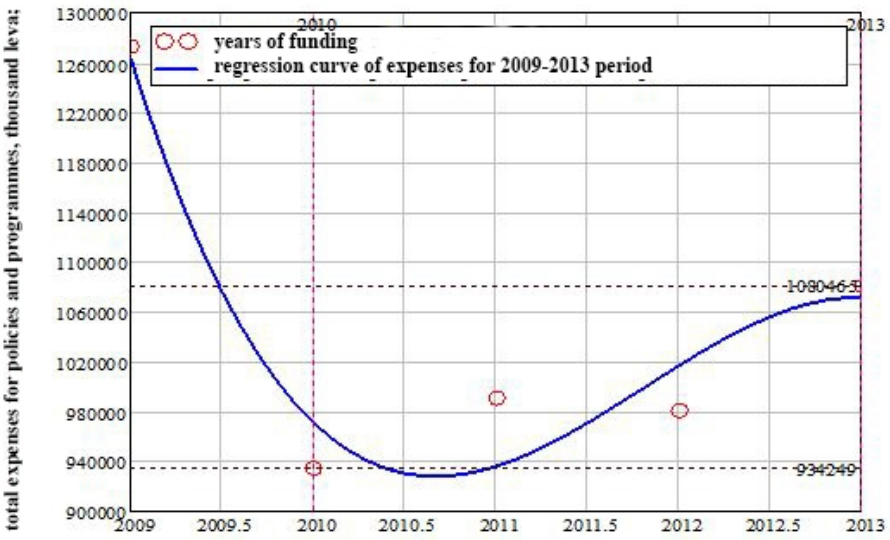

Fig. 1. Dynamics of military costs C_{mil}^{f} of policies and programmes for the 2009 - 2013 period

That dependence (23) allows to study the dynamics of the expenses during a specific period of funding, T_{mil} years. Determining the regularities of the changes C_{mil}^{f} according to (23) for the 2009 – 2013 period is given on Fig.1.

The changes in the costs C_{mil}^{f}, obtained through (23) show values for the period, used at $T_{pr}^{start} = 2010$ and $T_{pr}^{end} = 2013$ and is in sweep $934249 \le C_{mil}^{f} \le 1080465$ *leva* or a variation of costs $\Delta C_{mil}^{f} = 146216$ *leva*, shown on fig. 2.30. The changes to these data are shown in an equation of the following type with a variable:

$$hh(ss) := -289029828994.16681 \cdot ss + 143666490 \cdot ss^2 + -23803.833333 \cdot ss^3 + 193824403770485.69$$

hh(ss) =-289029828994.16681.ss + 143666490 ss2 + -23803.833333.ss3 + 1938244037770485.69

$$B_{mil}, R_{fin}, C_{mil}^{f}, A_{cap}, E_{ff}, D_{pol}, D_{pro}, P(x), T_{mil}, T_{pr}^{f}, M_{pos}, \pm \Delta C_{mil}^{f} \quad (24).$$

The analysis of (24) makes it possible to study the trends in C_{mil}^{f} formation of the military budget and the determining of the estimates for the subsequent time periods.

Step 2. Determining the magnitude of the estimated costs C_{mil}^{f} for a specific forecast period T_{pr}^{f}.

Determining the magnitude of variation of a forecast - $\pm \Delta C_{mil}^{f}$ in the forecast period T_{pr}^{f}, is realised through an analysis of the dynamics of the expenses during this period. In the general case the model of the forecast P_r^T includes a few components and is given as follows:

$$P_r^T = Y_T + Y_T^{mean} + \Delta K_{pr} + P_{dev}, \qquad (25),$$

where: Y_T - the projected values of the time series of estimates for the expenses for specific

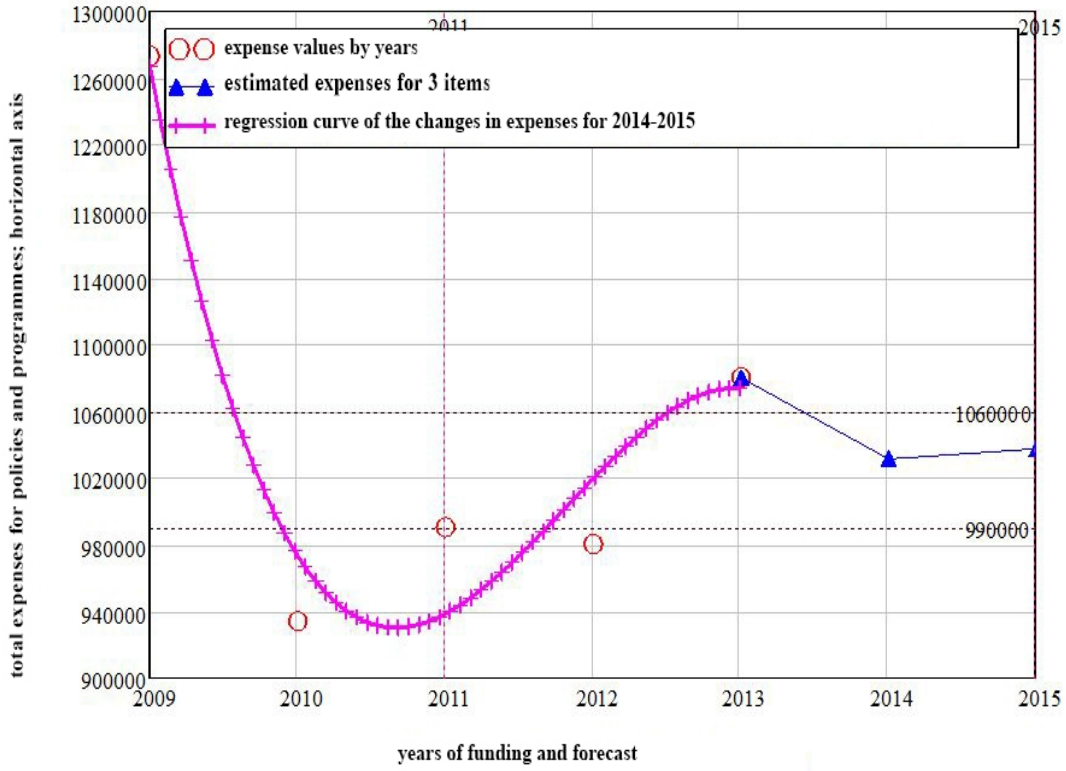

Fig. 2. Forecasting of the military costs C_{mil}^f of policies and programmes for the 2014 - 2015 period

years; Y_T^{mean} - average forecast (trend) for the expenses by years; ΔK_{pr} - fluctuations of the estimates for the expenses (fluctuation wave) for the years of forecasting; P_{dev} - random variable of deviation of the forecast from the average.

In individual cases for forecasting of the expenses, 2-3 years for example, the number of the components in (25) could be only the first three. This condition makes it possible to determine approximately the corrections K_{Pr} in the costs of specific policies or programmes within the forecast period. They could be determined from the following dependence:

$$K_{Pr} = f(Pr) \pm \Delta C_{mil}^f \frac{1}{2} \qquad (26).$$

The dependence (26) allows, through linear prediction (trend) of the future costs, to optimise that part of them which is a priority for the contracts and procurements that have already been signed. An option for realisation of the forecast based (26) on the expenditure values for three years for the 2014-2015 period is shown on Fig.2.

The confidence intervals for the conducted linear prediction for each three points in (26) allows the data for the expenses to be accepted as working values in implementation of the policies and programmes during the forecast years for funding with a higher degree of confidence.

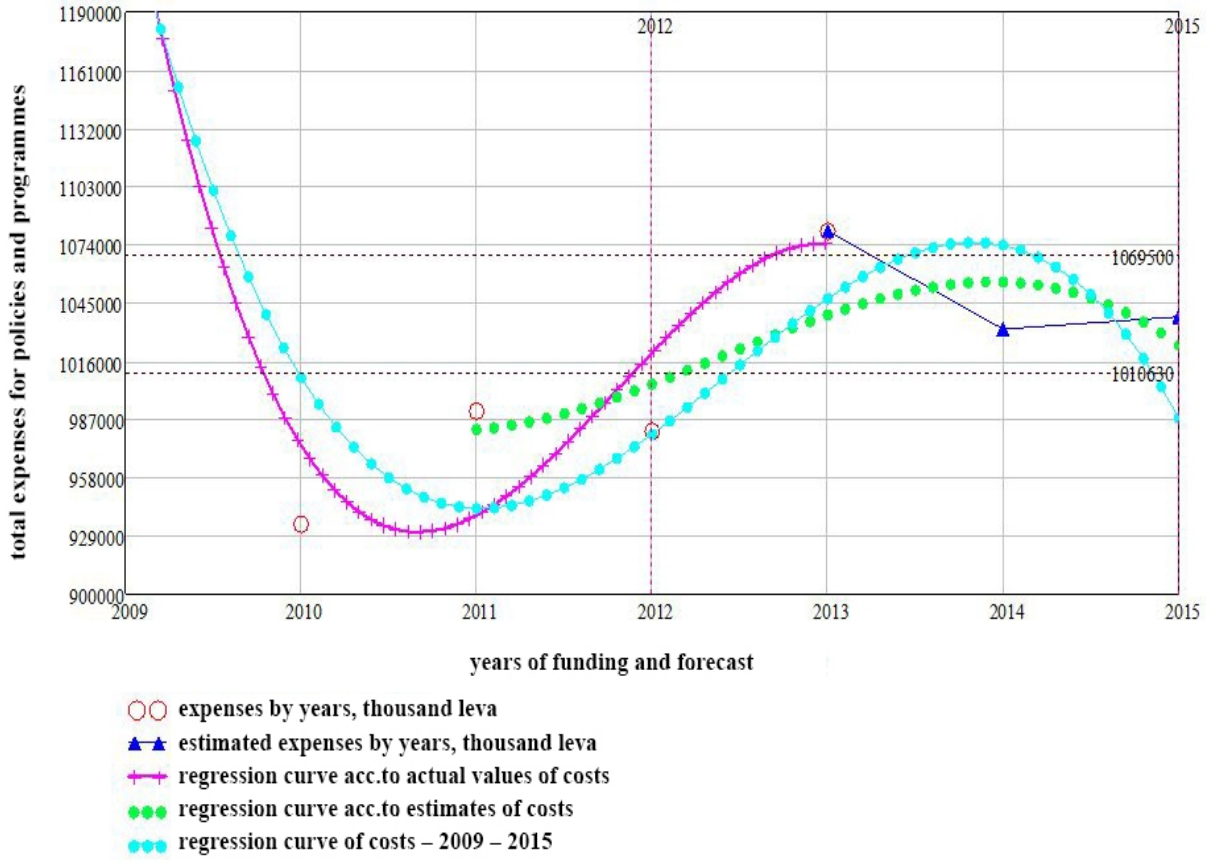

Fig.3. Forecasting of the military costs C_{mil}^{f} of policies and programmes for the 2014 – 2015 period through a general and local regression analysis

The projected values for the years and the costs are respectively $T_{pr}^{f} = 2014{,}2015 \ \ years$ and $C_{mil}^{f} = 990000{,}1060000 \ \ leva$ (Fig.2.).

When determining the random variable of deviation of the forecast P_{dev} (26), the average values of the costs by years could be used.

To reduce the statistical error from the linear prediction, iteration of the forecast is done. To achieve a greater accuracy of the estimated costs, the formalisation of the prediction problem includes a secondary regression analysis with the estimated values of the costs by years. Then the vector of the costs could be given as follows:

$C_{mil}^{f} = C_{mil}^{f}1, C_{mil}^{f}2, C_{mil}^{f}3..C_{mil}^{f}n + C_{mil}^{f}pr1, C_{mil}^{f}pr2..C_{mil}^{f}m$ (27),

where: $C_{mil}^{f}1, C_{mil}^{f}2, C_{mil}^{f}3..C_{mil}^{f}n$ is a vector of the actual, given costs of policies and programmes by years; $C_{mil}^{f}pr1, C_{mil}^{f}pr2...C_{mil}^{f}m$ is a vector of the estimated costs of time period of the forecast T_{pr}^{f}. Then the corrections K_{Pr} of the costs of specific policies or programmes within the forecast period could be determined by:

$$Kor = f\left(\frac{pr1 + pr2}{2}\right) \pm \Delta C_{mil}^{f} \frac{1}{2} \qquad (28).$$

Determining the corrections in connection with (28) is done by carrying out a regression analysis with estimating (27), for time T_{pr}^{f} which is shown on fig. 2.32.

Fig.3. Forecasting of the military costs C_{mil}^{f} of policies and programmes for the 2014- 2015 period through a general and local regression analysis

The estimated costs of policies and programmes for the period $T_{pr}^{f} \Rightarrow 2014 - 2015$ are described by an equation of the type:

KN(nn) := -5.55520961285714 nn + 2.7605006071429e7 nn^{2} + -4572.5 nn^{3} + 3.7264177260990023

where the values of the estimated costs for $T_{pr}^{f} = 2014{,}2015 \ years$ are $C_{mil}^{f} = 1012200{,}1010800 \ leva$, (Fig. 3.).

The correction in the forecast of estimates for the costs for the years 2014,2015 - linear and regression, are calculated (28) due to the statistical error, where:

$$Kor_{2014} = (\frac{1031600 + 1055200}{2}) \pm (1069500 - 1069500)\frac{1}{2} = 41135 \approx 50000 \ leva$$

and by analogy for:

$$Kor_{2015} = 56935 \approx 60000 \ leva \qquad (29)$$

This methodology for a successive halving of the boundary intervals of the values of the estimated costs, calculated by linear and regression predictions, allows to sign contracts that have implementation periods exceeding one or more years. These values suggest reduction of the errors through improving the prediction by (2-4) years.

To improve the accuracy of the forecast still further for a specific period of time T_{pr}^{f}, a regression analysis is recommended at T_{pr}^{start} and T_{pr}^{end}, and reporting the results of the analyses of the estimates $C_{mil}^{f} pr1, C_{mil}^{f} pr2 ... C_{mil}^{f} m$, taken as time series. The accuracy of the estimated results in the time series of values

$C_{mil}^{f} pr1, C_{mil}^{f} pr2 ... C_{mil}^{f} m$ is determined by the mean values of the costs, obtained from: the costs, a result from the linear prediction $C_{mil}^{f} Ln$, the costs from the local prediction $C_{mil}^{f} Lo$ and the values of the global prediction $C_{mil}^{f} \Gamma$. Then we can assume as appropriate the values of the costs $C_{mil}^{f} W$, used at the time of their planning:

$$C_{mil}^{f} W = \frac{C_{mil}^{f} Ln + C_{mil}^{f} Lo + C_{mil}^{f} \Gamma}{3} \qquad (30).$$

An option for such a forecast and determining the data from $C_{mil}^{f} W$ is shown on Fig.3.

The accuracy of forecasting of the time series of costs using (30), fig. 2.33. increases by 18÷25% due to reduction in the errors, which occurres as a result of the averaging interval.

As a sequence for identifying trends for the changes in the time series of expenses –

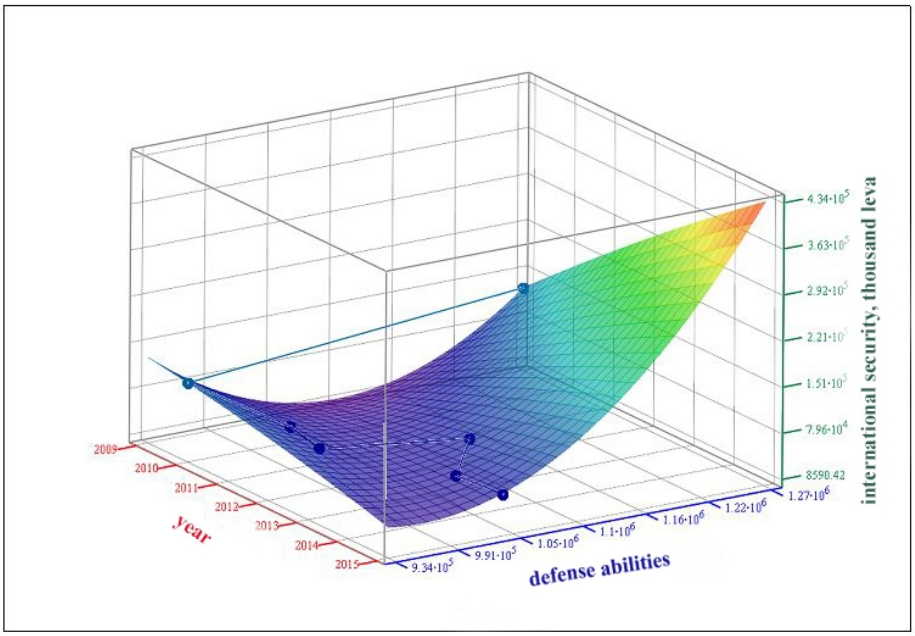

Fig.4.Mutual influence of the costs C_{mil}^{f} of policies and programmes for the 2009 – 2015 period

the existing and the estimated, the following algorithm is used where the values of the costs $C_{mil}^{f}W$ are divided into two approximately equal time intervals: first - N_1 and second - N_2 for the total interval $N_r = N_1 + N_2$ by years of forecasting. By assuming $T_{pr}^{start} = t_n$ and $T_{pr}^{end} = t_k$, the average appropriate value of the costs is determined $\overline{C_{mil}^{f}W}_1$ or $\overline{C_{mil}^{f}W}_1 = \frac{\sum_{t=t_n}^{N_1} C_{mil}^{f}W_t}{N_1}$

and the dispersion σ_1^2 or $\sigma_1^2 = \frac{\sum_{t=1}^{N_1}(C_{mil}^{f}W_t - \overline{C_{mil}^{f}W}_1)^2}{N_1 - 1}$.

By using the given dependences we check the hypothesis for absence of trend for reducing the deviations in the costs with the help of the t-criterion of Student. Thus, two areas of these time series are combined: the statistics of the volume of the sample by years and the depth, setting the forecast horizon.

Step 3. Determining the mutual influence of the policies and programmes on achieving the goals of the defense.

Generating aggregate defense possibilities M_{pos} through the complex impact of the policies and programmes is realised through a multidimensional regression analysis of input data, and these are the appropriate values of the costs $C_{mil}^{f}W$. The function is often of the following type:

$$P(x,y) = a_0 + a_1x^1 + a_2y^1 + a_3x^1y^1 + a_4x^2 + a_5y^2 \ldots\ldots a_k x^n y^m \quad (31).$$

The function (31) allows to study the simultaneous mutual influence of the policies and programmes when generating defense abilities. An option for a mutual influence of policies ‘Defense abilities’ and ‚Federal and international security’ for the 2009 – 2015 period is graphically shown on Fig.4.

The interdependence between the policies by using (31) demonstrates reduced values at their realisation. For the policy „Defense abilities" (Oig.4.) they are within the range of 105000 thousand leva ÷ 115000 thousand leva, whereas for the policy 'Federal and international security - 73 500 thousand leva ÷ 85 000 thousand leva. The mutual influence on them, regardless of the imbalance in the values of the costs $C_{mil}^{f}W$, suggests a greater influence on the defense abilities (fig.4) .

Step 4. Determining the mutual influence of the policies and programmes through the synergetic effect S_{ef} for generating defense abilities M_{pos}.

The synergetic effect S_{ef} means increasing the possibilities of a group of policies and programmes at the expense of their simultaneous influence. For this purpose the interconnection is determined by the weighted values of the coefficients for priority of the separate costs $k_1, k_2, k_3, ...k_x$ changed every year. The connection S_{ef} could be presented with the following dependence:

$$S_{ef} = k_1 C_{mil}^{f} W \vee k_2 C_{mil}^{f} W \vee k_3 C_{mil}^{f} W .....k_x C_{mil}^{f} W + \Delta S_{ef} \qquad (32),$$

where: ΔS_{ef} - effect of the interconnection of influence of the costs $C_{mil}^{f}W$, at the realisation of common programmes, etc.

To determine the effect of the interconnection ΔS_{ef} it is necessary to identify the local minimums and maximums of the regression surface, setting the changes of the overall costs of policies and programmes. The surface is defined by (32) for the 2009-2015 period and ΔS_{ef} is shown on Fig.5.

The reduction of costs of the policy „Defense abilities" and 'Federal and international security', fig. 6 generates a negative general effect where: the maximum value of the effect is:

$$\Delta S_{ef}^{\max} = \left\{ \begin{array}{l} \text{'defense abilities'} \quad 115000 \text{ leva} \\ \text{'federal and international security'} \quad 85000 \text{leva} \end{array} \right\},$$

And the minimum -

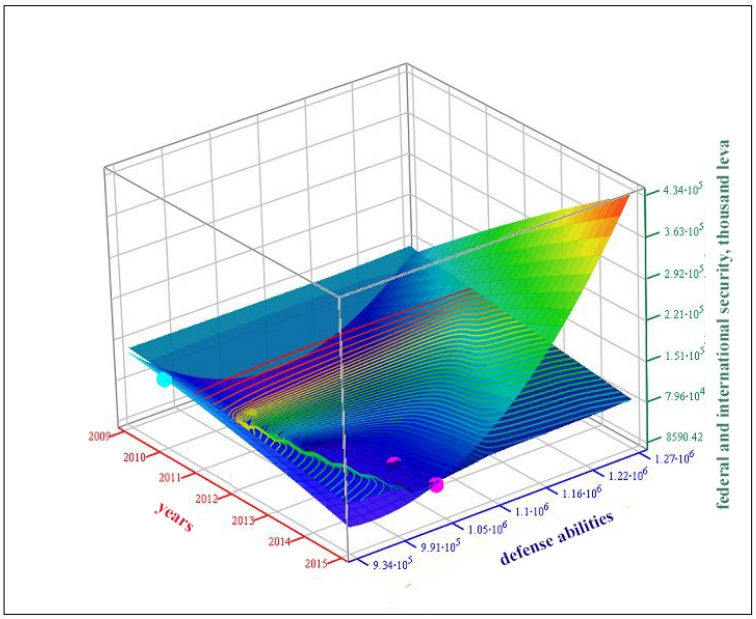

Fig. 5. Mutual influence of the costs $C_{mil}^{f}W$ of policies and programmes for the 2009 – 2015 and the synergetic effect

$$\Delta S_{ef}^{\min} = \begin{Bmatrix} 'defenseabilities' \quad 75000 \ leva \\ 'federal \ and \ \text{int} ernational \ \text{sec} urity' \quad 73000 leva \end{Bmatrix}.$$

These values of the effect show a negative trend of organisation of activities, envisaged in the prospective plan for the development of a specific policy or programme

The given mathematical model for analysis and forecasting of the costs for defense is a manifestation of the model 'resources-abilities-effects'. Through the used mathematical and statistical instruments, the forecasting of the expenses as an expression of the resources for security and defense, is in support of their transformation into defense abilities necessary for the Purposes of the AF, consistent with the dynamic changes in the environment of security. The application of the scientific approach, based on the mathematical and statistical tools in the proposed model, is in support of the rationalisation of the managerial decisions for the development of AF and the creating of a possibility for optimisation of the transformation of the resources into defense abilities in real time while complying with the level of ambition and priorities of the Defense Ministry.

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